Application of RESRAD 6.0 to Specific Conditions and Exposure Pathways at RFETS

A generalized discussion of the RSAL Working Group's approach to modeling Rocky Flats closure scenarios

1/17

KAISER-HILL COMPANY, LLC

Modeling Considerations

Many of the significant questions raised regarding site-specific modeling of RSALs can be reduced to these:

- Are the scenarios representative?
- Do the parameters represent the appropriate conditions?
- Will the model results represent the range of exposure conditions that might exist?

Scenarios

Exposure scenarios developed for the RFETS RSAL calculations are:

- Wildlife Refuge Worker - considered the most plausible given pending legislation
- Open Space Use - plausible given the valuable habitat and threatened species present
- Office Worker - specified in RFCA, but not immediately plausible; loss of institutional controls could allow such use
- Rural Resident - plausible following loss of institutional controls given present land use surrounding the Site

Relationship of Scenarios to Exposure Pathways

These scenarios suggest the exposed individual could:

- ingest contaminated soil while on Site,
- inhale contaminated air while on Site,
- be exposed to direct "shine" from radioactive materials in the soil,
- in "Rural Resident", eat contaminated vegetation or fruits grown on the Site, and
- arguably, in several cases, routinely ingest contaminated shallow-aquifer ground water.

Exposure Pathways

The previous slide suggests the following contaminant pathways be modeled:

- **Soil Ingestion**
- **Plant Ingestion**
- **External Radiation**
- **Inhalation**
- **Water**

The first three pathways are relatively straight-forward. "Inhalation" requires careful definition of scenarios. "Water" requires understanding of pathway "chemistry", especially for Pu/Am.

Exposure Parameters

Exposure within a given pathway is estimated (calculated) using a set of input parameters that specify either physical conditions or exposure factors for the individual.

Physical conditions are such things as root depth of plants, contaminant depth, windspeed, or anticipated air concentrations (mass loading).

Exposure factors are more physiologically based or institutionally based such as time indoors, inhalation rate, time outdoors, or exposure frequency (days per year on-site).

"Philosophy" for Assigning Parameters

- A point value is assigned when a parameter has little inherent variability and low uncertainty, or when its influence is unimportant to the model's result.
- Point values are generally representative of median values, not extremes.
- Distributions are developed for parameters having high variability and/or high uncertainty, especially when the outcome is sensitive.
- Distributions will be exercised to determine the realistic range of expected outcomes.

Brief Parameter "Case Studies"

1 - Assignment of Distribution Function (K_d) for Pu/Am

- All site-specific information is consistent with the presentation of K_d assumptions in the RAC Task 3 Report.
  - Data indicate Pu/Am highly insoluble
  - Colloidal transport is dominant in water
- RSAL will be calculated using geometric mean from RAC

Parameter Case Study

#2 - Air Mass Loading

- One of the more difficult physical conditions to anticipate is the air mass loading
- Site specific data and state-wide data can be used to determine the mass loadings that are likely to be observed at the Site. None of the scenarios suggests normal activities will cause significant excursions from this range of values -- however...

Case Study(continued)

- … less common events such as fires and reduced precipitation must be considered as potentially significant perturbations on that observed ML.
  - Site-specific information can be used to estimate the effect of reduced precipitation on ML
  - State records provide information about frequency of wildfires in the Front Range
  - No reliable information exists on effects of a prairie-grass wildfire on wind erosion other than the windtunnel tests recently performed at the Site.

#2 Mass Loading (continued)

Baseline Mass Loading

- Site-specific ML data includes, at the high end of the range, impacts from a relatively large construction project (Woman Creek Reservoir)
- Site-specific ML includes the effects of continuous vehicle traffic on both paved and dirt roads
- Site-specific ML includes overall effects of a 50+ head deer herd
- Statewide ML will portray probable impacts of growth.

#2 Mass Loading (continued)

Other Information

- On-site meteorological data span more than 35 years; include precipitation and wind data.
- Precipitation data allow estimates of periods with suppressed or enhanced emissions.
- Windtunnel data provide elevated erosion factors that can be applied to baseline ML.
- Multiple windtunnel tests provide information useful to estimating recovery periods following grassfires.

#2 Mass Loading (continued)

How are the data used?

Data	Point/Distrib?	Used for?
Site/Statewide air conc.	Point Value	Baseline mass load (ML_b)
Precipitation	Contrib. To Distrib.	Impact (Dust), frequency with dust
Front Range fire data	Contrib. To Distrib.	Spring/Fall partition frequency
Windtunnel data	Distribution	Erosion multiplier (EM)
		Recovery estimates

Estimation Method

$$(ML)^p = ML_b * (Dust) * (EM)$$

^{p} (parentheses used to indicate distributions)

KAISER-HILL COMPANY, LLC

The Mass Loading Input

- The resulting mass loading will mimic a statistical distribution.
- Assumptions about the characteristics of that distribution allow assignment of a distribution function.
- The distribution function will be input into RESRAD

Other Model-Related Considerations

Other factors that need to be understood relate to the model itself:

- What conditions can be modeled? (no colloidal transport)
- What types of inputs are required? (next slide)
- What outputs can be expected? (stochastic vs deterministic results)

"Challenges" in Parameter Assignment

Certain parameters must be input to the model in ways that are not intuitively obvious, or realistic.

Examples:

- **(not obvious) "Indoor time fraction" is not the fraction of time one spends indoors, on-site while working, but the fraction of time one spends indoors, on-site, on a 24-hour annualized basis.**
- **(not realistic) "Mass Loading", to represent an area source, must consider any disturbance as distributed over the entire field of influence, not in just the contaminated area.**

Final Mass Loading Note

One final note on mass loading, tied to the model features --

- An area factor is used to interpolate the amount of airborne soil that is contaminated.
- Site knowledge allows the area factor to be bounded to a realistic size representing extent of actual contamination.

KAISER-HILL COMPANY, LLC

17/17